THERMOSPHERE, IONOSPHERE, MESOSPHERE ENERGETICS AND DYNAMICS MISSION (TIMED)

LEVEL 1 REQUIREMENTS DEFINITION

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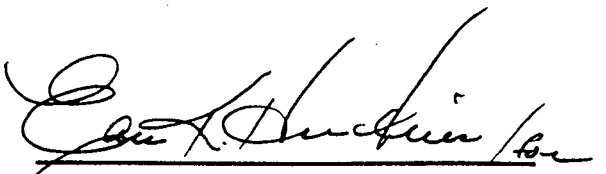
Approved by:



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Thermosphere Ionosphere Meseophere Energetics Dynamics (TIMED) Level 1 Requirements Definition

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TIMED Level 1 Requirements Definition

1.0 PURPOSE

This document defines the Level 1 Requirements for the development of the Thermosphere Ionosphere Mesosphere Energetics Dynamics (TIMED) Mission. Concurrent with the initiation of the Development Phase, the Level 1 Requirements will be incorporated into the TIMED Program Plan, which will be approved by the Associate Administrator for the Office of Space Science (OSS), and the Director of the Goddard Space Flight Center (GSFC).

2.0 MISSION OVERVIEW

TIMED will investigate and attempt to understand the energetics of the Mesosphere and Lower Thermosphere/Ionosphere (MLTI) region of the Earth's atmosphere from ~60 to 180 km altitude. The MLTI is a region of transition in which many important processes change dramatically. TIMED will be launched nominally into a 625 km altitude circular orbit at a 74.1^0 inclination earth orbit. TIMED is planned to collect data for two years in order to provide sufficient observation time to meet the science objectives and understand the seasonal and solar cycle variability's. Operation of the mission beyond two years would provide observing time to perform follow-up studies of anticipated important discoveries.

2.1 Scientific Objectives

The primary objective of the TIMED mission is to perform an exploratory study of the physical and chemical process acting within and upon the coupled mesospheric, and ionospheric system between ~60 and 180 km altitude.

2.1.1 Radiative Sources and Sinks

TIMED will make direct measurements of the energy gains and losses through various radiative processes, together with measurements of the basic state parameters including the wind system that transports the radiatively-active species. These measurements will provide critical data to improve our theoretical understanding of the energy budget of the MLTI region.

2.1.2 Dynamical Sources and Sinks

TIMED will make observations of the thermal structures of the MLTI region and provide the needed additional data base (wind structure, the solar heating rates, and infrared cooling rates) to address the question of MLTI Dynamical heating.

2.1.3 Electrodynamical Energy Sources and Sinks

TIMED will identify and quantify the flow of energy into the MLTI region from the magnetosphere by making measurements necessary for the determination of the solar EUV/UV irradiances, particle input, Joule heating, and atmospheric response simultaneously and under varying conditions of solar activity.

2.1.4 Chemical Heating

TIMED will provide key measurements of several important airglow emission rates so that accurate solar heating and chemical heating efficiencies can be obtained. In addition, TIMED will also either directly measure or infer the concentrations of the necessary minor species to examine the chemical heating rates.

2.2 Program Management Implementation

The TIMED Mission will be developed and operated for NASA by the Johns Hopkins University/Applied Physics Laboratory (JHU/APL), with the NASA GSFC as the responsible Field Center. The JHU/APL is responsible for the design, development, and testing of the spacecraft, ground system, and the technical management of the scientific instruments. Scientific instruments will be provided by the University of Colorado; the University of Michigan; the Aerospace Corporation; and the NASA/Langley Research Center (LaRC).

Six Interdisciplinary scientists will participate in the TIMED Mission. The JHU/APL Project Scientist, will lead this investigative team. There is no Principal Investigator for the TIMED mission.

Program implementation will incorporate, through management of risk, a balance of subsystem reliability, redundancy, system reliability and robustness, and the lower-cost, rapid response philosophy of the Explorer Program.

3.0 LEVEL 1 SCIENCE REQUIREMENTS

3.1. The following four instruments shall be deployed on TIMED to accomplish the above scientific objectives:

3.1.1. The Solar EUV Experiment (SEE), developed by the University of Colorado, shall contain photometers and a spectrometer to measure solar X-ray, UV and FUV irradiances wavelengths of 0.1nm to 200 nm.

3.1.2. The Sounding of the Atmosphere using Broad band Emission Radiometry (SABER) instrument, developed by the NASA/LaRC, shall be a multichannel radiometer to measure the pressure, temperature, and infrared cooling rates in the MLTI region.

3.1.3. The Global Ultraviolet Imager (GUVI), developed by the Aerospace Corporation, shall contain a spatial scanning UV Spectrograph, with a wavelength range of 115 nm to 180 nm to measure composition and temperature in the Lower Thermosphere and Ionosphere.

3.1.4. The TIMED Doppler Imager (TIDI), developed by the University of Michigan, shall be a Fabry-Perot Interferometer to measure winds and temperature in the MLTI region.

3.2. The orbit altitude shall be high enough so that the imaging instrument (GUVI) can provide a swath width of at least 130 km.

3.3. Solar flux measurements obtained by SEE shall not be significantly attenuated by atmospheric absorption.

3.4. The limb viewing remote sensing instruments, TIDI and SABER, shall have a vertical resolution of at least 2 km.

3.5. The effect of off-axis scattering from the bright limb on the measurements obtained by TIDI shall be minimized to be within 10% of the signals.

3.6. Orbit inclination shall be high enough so that global measurements (at all latitudes) can be obtained by the three limb-viewing remote sensing instruments (GUVI, SABER, and TIDI) and the auroral zones (auroral energy input) can be imaged by GUVI.

3.7. Orbit parameters shall be such that the local time drift rate will allow a complete 24 hour local time measurement within a season. To aid discrimination between temporal and spatial variations, a precise inclination is desired so that the local time of the ascending node obtained at a particular date during the first year will be approximately the same one year later.

4.0 LEVEL 1 PROGRAMMATIC REQUIREMENTS

4.1. The total cost of TIMED Study and Development Phases (Phases B/C/D) shall not exceed the $129.3 M cost cap agreed upon at the time of the Non-Advocate Review and subsequent PMC confirmation to initiate development. Mission scope shall be considered as a parameter to control mission cost and schedule. APL may, in consultation with the Headquarters Program Scientist, pursue scope reduction, as outlined in Section 6.0 below, as an additional resource to manage cost.

4.2. The flight segment, consisting of a spacecraft and four science instruments, shall be designed for a minimum mission life of two years. This mission duration shall be achieved without the necessity of an on-board propulsion system.

4.3. TIMED shall be launched on a Delta 2 expendable launch vehicle from the Western Test Range at Vandenberg AF Base, California. The launch shall be in the first half of 2000.

5.0 LEVEL 1 MISSION OPERATIONS & DATA ANALYSIS (MO&DA) REQUIREMENTS

5.1. The TIMED mission operations center shall be located at the JHU/APL. The instrument operation centers shall be located at the instrument investigator's institution where the Instrument Command Uploads will be developed. Following in-orbit checkout and commissioning of the four science instruments, TIMED will be operated by the JHU/APL to accomplish the four Instrument Principal Investigator's observing programs, and the observing programs of the six interdisciplinary scientists.

5.2. The TIMED ground system shall provide mission operations, science operations, ground communications, orbit determination, and data processing. Communications, tracking, and support shall be the responsibility of JHU/APL. Emergency communications will be supported by the GSFC.

5.3. No data products generated by the TIMED mission are to be considered proprietary. All data will reside in the public domain, and no access restrictions shall be placed on the data to prevent its use by anyone.

5.4. The policies and guidelines for access and distribution of TIMED science data shall be specified in the TIMED Project Data Management Plan.

5.5. TIMED science data provided to the TIMED investigators for analysis shall include raw and calibrated data and be provided in a format compatible with public-domain software packages and with facilities archiving, catalog searching, and data retrieval. Raw and calibrated science data and related documentation shall be archived in a long-term facility for future access by the scientific community and the public.

6.0 COST MANAGEMENT AND SCOPE REDUCTION

Provided that the Level 1 Requirements are preserved, and that due consideration has been given to the use of budgeted contingency and planned schedule contingency, shall pursue scope reduction as a means to control cost. The JHU/APL TIMED Management Plan shall include potential scope reductions and the time frame in which they could be implemented. If other methods of cost containment are not practical, the reductions identified in the Management Plan may be exercised without further NASA approval, however any reduction in scientific capability will be implemented only after consultation with the Program Scientist. Any potential scope reductions affecting Level 1 Requirements shall be

agreed to by the GSFC Mission Manager and NASA Headquarters prior to their implementation.